

# A Bibliometric Study of Asia Pacific Software Engineering Conference from 2010 to 2015

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**Abstract**—The Asia-Pacific Software Engineering Conference (APSEC) is a reputed and a long-running conference which has successfully completed more than two decades as of year 2015. We conduct a bibliometric and scientific publication mining based study to how the conference has evolved over the recent past 6 years (year 2010 to 2015). Our objective is to perform in-depth examination of the state of APSEC so that the APSEC community can identify strengths, areas of improvements and future directions for the conference. Our empirical analysis is based on various perspectives such as: paper submission acceptance rate trends, conference location, scholarly productivity and contributions from various countries, analysis of keynotes, workshops, conference organizers and sponsors, tutorials, identification of prolific authors, computation of citation impact of papers and contributing authors, internal and external collaboration, university and industry participation and collaboration, measurement of gender imbalance, topical analysis, yearly author churn and program committee characteristics.

**Index Terms**—Asia-Pacific Software Engineering Conference, Bibliometric Analysis, Mining Scientific Papers, Software Engineering Research Reflection

## I. RESEARCH MOTIVATION AND AIM

The Asia-Pacific Software Engineering Conference (APSEC) is an annual conference started in the year 1994 in Tokyo (Japan) with the aim of bringing software engineering researchers and practitioners from both university and industry around the world to exchange research results and ideas. APSEC 1994 (Tokyo, Japan) was the first edition of the conference and the annual event completes 23 editions in 2016 (Hamilton, New Zealand). More than two decades of APSEC has been successful in providing a forum to share cutting-edge advancements in the field of software engineering and has become one of the important academic events for researchers and scholars (particularly in the Asia-Pacific region) working in the area of software engineering. The number of national and international delegates participating in APSEC series of conferences every year, citation impact of the published scientific papers (research and industry track), quality of peer-reviews, number of papers submitted to the various conference tracks, diversity and quality of co-located events such as workshops and tutorials, keynotes and invited talks, professional reputation of the organizing and program committee members and support from industry as well as government agencies as sponsors are clear evidences indicating that APSEC has maintained its reputation and high quality. We believe that a reflection of the recent past

(year 2010 to 2015) of APSEC is important for the APSEC community for learning and further improving the impact and quality of the conference.

The bibliometric and scientific publication mining based study presented in this paper is motivated by the need to conduct a quantitative and objective evaluation and assessment of past 6 years of APSEC. Our research motivation is to investigate answers to questions such as: how the conference has evolved over the past 6 years and what is the current status, what is the quality of the conference based on several key performance indicators, what improvements can be made and to what extent APSEC is meeting its desired objectives. Our research aim is to systematically and scientifically explore and examine the state of APSEC across various aspects of the conference. To the best of our knowledge, the study presented in this paper is the first in-depth examination of the state of APSEC which we believe is important for the APSEC community to understand its development, evolution and identify future directions.

## II. RELATED WORK AND RESEARCH CONTRIBUTIONS

In this Section, we present related work and the novel contributions of the study presented in this paper in context to existing work. Tripathi et al analyze research papers published in MSR (Mining Software Repositories) series of conferences from 2010 to 2014 (a period of 5 years) [1]. Sharma et al. conduct a bibliometric study consisting of mining 551 papers in Requirements Engineering (RE) series of conference of [2]. Sharma et al. analyze 11 years of RE papers published from the year 2005 to 2015. They study several aspects such as: authorship numbers and scholarly productivity of various countries or regions, interdisciplinarity, topic modeling and categorization, collaboration (university and industry, internal and external) and public and proprietary dataset [2]. Agarwal et al. conduct a research study on gender imbalance and low participation of women in Computer Science Research (CSR) [3]. They conduct several empirical and statistical analysis consisting of mining thousands of bibliometric entries in DBLP<sup>1</sup> bibliography data [3]. Their findings reveal that in the broad field of Computer Science, there is a gender balance wherein only 21% of the authors are female and 79% are male authors. They study several

<sup>1</sup><http://dblp.uni-trier.de/>

aspects of the conference like national and international collaboration, university and industry collaboration, research type of the study (validation, evaluation, solution proposal, philosophical, opinion and experience), contribution (such as tooling or metric) and technology area [4]. Barn et al. present a systematic mapping study to all the papers published in Indian Software Engineering Conference (ISEC) series since its beginning [4]. Freitas et al. perform a bibliometric analysis of 740 scientific papers published in Search Based Software Engineering (SBSE) series of conference from the year 2001 to 2010 [5]. Bergamaschi present a quantitative analysis of WWW, Hypertext (HT) and JCDL which are three of the seven ACM SIGWEB sponsored conferences [6]. Bartneck present a historical overview of the long-running and prestigious conference on Human Robot Interaction (HRI) [7]. Bartneck et al. present a scientometric analysis of the CHI (one of the top-most conference on Human Computer Interaction) proceedings [8]. Agarwal et al. present a bibliometric analysis of the scientific publications and corresponding ACM metadata (also published as a research output) of seven conferences sponsored by ACM SIGWEB [9].

**Research Contributions:** In context to existing work, the study presented in this paper makes several novel research contributions. The work presented in this paper is the first in-depth and focused study on analyzing Asia-Pacific Software Engineering Conference (APSEC) across various perspectives: paper acceptance rates, conference location, scholarly output of various countries, keynotes, workshops, conference organizers and sponsors, tutorials, prolific authors, citation impact, internal and external collaboration, university and industry participation and collaboration, gender imbalance, topical analysis, yearly author churn and program committee characteristics.

**Dataset Contributions:** We make our dataset publicly available on figshare<sup>2</sup> which is a web platform for storing, sharing and discovering research [10]. We believe that sharing our dataset will further facilitate research on APSEC bibliometric analysis and can be used to explore new research problems and hypothesis. Extracting data from a large number of papers required manual effort as well as writing scripts and web believe that the research community can benefit from our shared data.

**Extended Version of Previous Paper:** The study presented in this paper is an extended version of the short paper accepted in APSEC 2016 by the same authors [11]. Due to the four page limit of the APSEC 2016 paper, several aspects are not covered which are described in this paper. The objective of this paper is to provide a complete and detailed analysis of our work on APSEC bibliometric analysis (year 2010 to 2015) through arXiv open access<sup>3</sup>.

<sup>2</sup><https://figshare.com/>

<sup>3</sup><https://arxiv.org/>

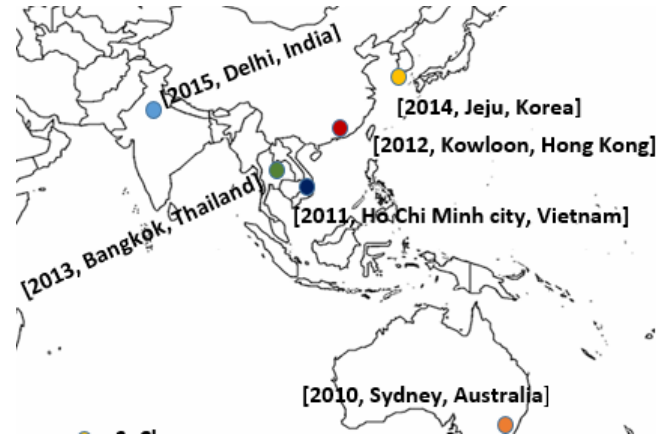


Fig. 1. Map of Asia-Pacific Region displaying the Conference Location, Year and General Chairs for APSEC 2010 to APSEC 2015

TABLE I  
NUMBER OF PAPERS SUBMITTED (SUB), RESEARCH REGULAR (REG), RESEARCH SHORT OF POSTER (SHR), INDUSTRY TRACK (IND), EMERGING RESEARCH (ERA), ACCEPTED (ACC) AND ACCEPTANCE RATE (AR) APSEC FROM 2010-2015

Year	REG	SHR	IND	ERA	ACC	SUB	AR
2010	47	0	17*	0	47	151	47/151 = 31.12%*
2011	49	0	0	0	49	178	49/178=27.52%
2012	51	48	23*	-	99	200	99/200 = 49.5%*
2013	61	14	12*	-	75	167	75/167 = 44.91%*
2014	58	4	7	-	69	226	69/226=30.53 %
2015	42	-	9	-	51	182	51/182=28.02%

### III. LOCATION, ACCEPTANCE RATE AND ORGANIZERS

Figure 1 shows the city, country and year for APSEC 2010 to 2015. The map in Figure 1 shows that the conference is being organized in different countries in the Asia-Pacific region and hence there is a geographical balance in-terms of the conference location. We observe that from the year 2010 to 2015, the conference is generally being organized in one of the largest cities of the hosting country except in the year 2014 (Jeju Island, Korea). We download all the APSEC 2010 to 2015 papers from the IEEE digital library for our analysis. We compute the acceptance rate and number of papers submitted each year based on the papers available in the IEEE digital library and the information provided by the program chairs in the front matter or message for the program chair(s) section of the proceedings. We observe several inconsistencies and incompleteness of the data in message from the program chairs. For example, for the year 2013, the number of submission are provided only for the research track and not for other tracks. For the year 2010 there are no industry track in the proceedings but the website shows an industry track. For the year 2012, we compute acceptance rate based on the 99 research track paper (51 full papers and 48 short papers) as the submission data of ERA and IND track is not given.

Table I shows the number of papers accepted and submitted across various tracks and the acceptance rate or selectivity of the conference. Table I reveals that the acceptance rate varies from a minimum of 27.52% to a maximum of 49.5%. Table

TABLE II  
CONFERENCE LOCATION, GENERAL CHAIR(S), PROGRAM CHAIR(S) AND SPONSORS OF APSEC FROM 2010 TO 2015

Year	Location	General Chair	Program Chair	Sponsors
2015	New Delhi, India	Srinivas Padmanabhuni, Infosys, India; Ashish Sureka, ABB Corporate Research, India	Jing Sun University of Auckland, New Zealand; Y. Raghu Reddy IIIT Hyderabad, India	Infosys, TCS, ACM India, ISOFT
2014	Jeju, Korea	Sungdeok (Steve) Cha, Korea University, Korea	Yann-Gal Guhneuc, Polytechnique Montr�al, Canada; Gihwon Kwon, Kyonggi University, Korea	Kisti, Nipa, Etri, LG Electronics, Samsung Electronic, Solution Link, SSDRC, ESG, Suresoft
2013	Bangkok, Thailand	Prabhas Chongstitvatana, Chulalongkorn University, Thailand; Pansak Siriruchatapong, NECTEC, Thailand	Pornsiri Muenchaisri, Chulalongkorn University, Thailand; Gregg Rothermel, University of Nebraska, USA	TCEB, Provincial Electricity Authority, Metropolitan Electricity Authority
2012	Kowloon, Hong Kong	T.H. Tse, The University of Hong Kong, China; S.C. Cheung, The Hong Kong University of Science and Technology, China	Karl Leung, The Hong Kong Institute of Vocational Education, China; Pornsiri Muenchaisri, Chulalongkorn University, Thailand	IEEE Hong Kong Section Computer Society Chapter, ACM Hong Kong Chapter, ACM Chapter Conference
2011	Ho Chi Minh city, Vietnam	Bach Hung Khang, Institute of Information Technology, Vietnam; Duong Anh Duc, University of Science, VNU-HCM, Vietnam	Tran Dan Thu, University of Science, VNU-HCM, Vietnam; Karl Leung, Hong Kong Institute of Vocational Education, China	Department of Information and Communication, HCM City Information Sponsor, Information Technology Center - University of Science HCMU Financial Sponsor, TMA Solution - Leading Software Outsourcing Company in Vietnam Sponsor for Gifts of Industrial Section
2010	Sydney, Australia	Paul Strooper, The University of Queensland, Australia; Ross Jeffery, National ICT Australia (NICTA), Australia	Jun Han, Swinburne University of Technology, Australia; Tran Dan Thu, University of Science - HCMC VNU, Vietnam	National ICT Australia (NICTA), IBM, Microsoft Research, Australian Safety Critical Systems Association, Swinburne University of Technology, The University of Queensland

TABLE III  
LIST OF KEYNOTES AT APSEC 2010 TO APSEC 2015

Year	Title	Speaker
2010	The Data Deluge, How Software Engineering can Help Changes in the Software Development Profession to Meet the Need for Innovation from Businesses and Government	Judith Bishop, Microsoft (USA) Martin Nally, IBM (USA)
2011	Future Software Engineering Opportunities and Challenges Software Process Definition	Barry W. Boehm, University of Southern California, USA Leon J. Osterweil, University of Massachusetts, USA
2012	Whither Software Architecture? Whither Software Engineering Research? Blended Program Analysis for Improving Reliability of Real-world Applications	Jeff Kramer, Imperial College London, UK David S. Rosenblum, National University of Singapore, Singapore Barbara G. Ryder, Virginia Tech, USA
2013	Useful Software Engineering Research: Leading a Double-Agent Life Practices of Software Engineering in Thailand Achieving Success in Open Software Ecosystems: The Role of Architectural Styles	Lionel C. Briand, FTSC, University of Luxembourg Dr. Kanchit Malaivongs, Royal Institute of Thailand Richard Taylor, University of California, Irvine
2014	Strategy Introduction of Embedded Software Competence for IoT era Powers of Two: Cultures, Solitudes and Software Engineering Architecting = Decision Making	Jeonghan Kim(Brian), Samsung Electronics, Korea Mike Hoyer, Mozilla, Canada Hans van Vliet, VU University Amsterdam
2015	Evolving Critical Systems Building an Open Identity Platform for India Trends in Automation and Control Systems Needing Efficient Software Engineering	Dr Minke Henchey, University of Limerick (UL), LERO Dr Pramod Varma, Chief Architect, UIDAI Mr Akilur Rahman, Head of ABB INCRC, India

I shows that the number of papers submitted to APSEC falls in the range of 150 to 230. We observe that several tracks like short papers, industry track and emerging research track are not conducted every year and are not regular features of APSEC. Table II displays the Conference Location, General Chair(s), Program Chair(s) and Sponsors of APSEC from 2010 to 2015. Table II shows that the conference leadership (general and program Chairs) have representation mostly from university and rarely from industry (except in the year 2015 when both the general and program chairs were from industry). The list of sponsors mentioned in Table II that APSEC receives sponsorship and support from all the sectors: university, industry and government.

#### IV. KEYNOTES, WORKSHOPS AND TUTORIALS

Table III shows the list of keynotes at APSEC 2010 to APSEC 2015. We extract the keynote information from the

extended abstract for keynote included as part of the conference proceedings. We observe a good mix of keynotes from industry (such as ABB, IBM, Microsoft and Samsung), government (such as UIDAI) and university. We notice a talk from non-profit corporations like Mozilla Foundation. Table III shows that keynote speakers are from various parts of the world and are invited from countries outside the host country which shows conference diversity and inclusiveness. Table IV shows the list of workshops at APSEC 2010 to APSEC 2015. We observe co-located workshops to APSEC on diverse topics such as cloud computing, embedded systems, software testing, software quality, empirical software engineering, software engineering education, alternate workforces and quantitative approaches to software quality. Normally, there are two co-located workshops to APSEC expect for the year 2011 when there was only one co-located workshop and year 2015 when

TABLE IV  
LIST OF WORKSHOPS AT APSEC 2010 TO APSEC 2015

Year	No.	Workshop
2010	1	Cloud Computing
	2	Software Engineering for Embedded Systems
2011	1	International Workshop on Recent Progress in Software Engineering
2012	1	International Workshop on Software Analysis, Testing and Applications
	2	International Workshop on Software Quality and Management
2013	1	The 5th International Workshop on Empirical Software Engineering in Practice (IWESSEP 2013)
	2	International Workshop on Quantitative Approaches to Software (QuASoQ 2013)
2014	1	2nd International Workshop on Quantitative Approaches to Software Quality (QuASoQ 2014)
	2	Software Engineering Education Workshop (SEEW)
2015	1	Quantitative Approaches to Software Quality (QuASoC)
	2	Alternate Workforces for Software Engineering (WAWSE)
	3	Case Method for Computing Education (CMCE)

TABLE V  
LIST OF TUTORIALS AT APSEC 2010 TO APSEC 2015

Year	No.	Tutorial
2011	1	Requirements Engineering Based on Requirements Engineering Body Of Knowledge (REBOK)
	2	A Process Decision Framework: The Incremental Commitment Spiral Model
2012	1	A Survey of Domain Engineering
	2	Requirements Engineering Based on REBOK (Requirements Engineering Body of Knowledge) and its Practical Guide
	3	Product Line Requirements Reuse based on Variability Management
2013	1	Requirements Engineering Based on REBOK (Requirements Engineering Body Of Knowledge and its Practice
	2	SAT and SMT their algorithm designs and applications
	3	Modelbased Transition from Requirements to Highlevel Software Design
	4	Software Reuse based on Business Processes and Requirements
2014	1	Metamorphic Testing
	2	Using Artificial Intelligence Techniques for Requirements Engineering Research
	3	Embedded Software Design in the Hardware/Software Code-sign Methodology
2015	1	Building Enterprise-grade Internet of Things Applications
	2	Software Defined Storage Technology

there was 3 co-located workshops. Table V shows the list of tutorials at APSEC 2010 to APSEC 2015. Table V reveals that there are at-least 2 tutorials conducted with APSEC every-year and the tutorial covers diverse topics within software engineering.

## V. CITATION BASED IMPACT

One of the major factors used to evaluate the quality of a conference is to measure the overall impact of the papers published or presented in the conference. The number of citations or references in other publications received by a scientific paper is an indicator of the impact of the paper. Google Scholar<sup>4</sup> is a popular and widely used search engine as well as a citation metrics service which keeps tracks of

<sup>4</sup><http://scholar.google.com/>

citations to articles indexed by it. We compute the number of citations for all the papers published in APSEC from the year 2010 to 2015. The total number of citations as of 5 May 2016 in year 2010, 2011, 2012, 2013, 2014 and 2015 are 642, 340, 386, 179, 53 and 0 respectively. The total number of citations from year 2010 to 2016 is 1600. The h5-index for APSEC on 5 May 2016 is 13. Google Scholar defines h5-index as "h5-index is the h-index for articles published in the last 5 complete years. It is the largest number h such that h articles published in 2010-2014 have at least h citations each". The h5-median for APSEC on 5 May 2016 is 18. Google Scholar defines h5-median as "h5-median for a publication is the median number of citations for the articles that make up its h5-index".

Table VI shows the Top 10 most cited APSEC papers in our dataset. Table VI reveals that only one paper has received more than 50 citations and 6 out of 10 have received more than 25 citations. The minimum number of citations received by the Top 10 papers is 20. Table VI shows the first author name and country of affiliation of the first authors. The data in Table VI shows a wide diversity of scholarly output and contributions to APSEC from various countries. Garousi et al. [12] conducted a study, comprised of five research questions, to identify and classify the top-100 highly-cited SE papers in terms of two metrics: total number of citations and average annual number of citations. According to their study International Conference on Software Engineering (ICSE), International Conference on Requirements Engineering (RE), Conference on Object-Oriented Programming Systems, Languages, and Applications (OOPSLA), IEEE/ACM/IFIP International Conference on Hardware/Software Codesign and System Synthesis (CODES+ISSS) and IEEE/ACM International Conference on Automated Software Engineering (ASE) are the top five conference venues for software engineering papers. APSEC does not appear in the list of conferences under the category of venues for top papers. The h5-index for APSEC on 5 May 2016 is 13 whereas the h5-index<sup>5</sup> of several broad scoped software engineering conferences computed by the MSR committee on December 31, 2014 is: ICSE (57), FSE (38), ASE (30) and ESEM (24). Table VII displays

TABLE VII  
DESCRIPTIVE STATISTICS FOR APSEC 2010 TO 2015 GOOGLE SCHOLAR CITATIONS

Year	Min.	Max.	Mean	Med	Skew	Kurt	Sum
2010	0	173	13.66	9	5.37	33.84	642
2011	0	41	6.94	6	2.90	14.77	340
2012	0	27	3.16	2	2.87	16.72	386
2013	0	21	2.06	1	4.10	24.86	179
2014	0	6	0.77	0	1.89	6.97	53
2015	0	0	0.00	0	0.00	0.00	0
All	0	173	4.28	2	11.92	186.71	1600

the descriptive statistics for APSEC 2010 to 2015 Google Scholar Citations. The mid-point (median value) in-terms of the number of citations for the year 2010 is 9 and for the year 2011 is 6. Table VII reveals that half of the papers in

<sup>5</sup>[http://2015.msrconf.org/MSR\\_Impact.pdf](http://2015.msrconf.org/MSR_Impact.pdf)

TABLE VI

TOP 10 MOST CITED APSEC 2010 TO 2015 PAPERS BASED ON GOOGLE SCHOLAR METRICS (CITATIONS METRICS COLLECTED ON 5 MAY 2016)

Rank	Year	Paper Title	First Author	Country	Citations
1	2010	The Qualitas Corpus: A Curated Collection of Java Code for Empirical Studies	Ewan Tempero	New Zealand	173
2	2010	Detecting Duplicate Bug Report Using Character N-Gram-Based Features	Ashish Sureka	India	42
3	2011	DREX: Developer Recommendation with K-Nearest-Neighbor Search and Expertise Ranking	Wenjin Wu	China	41
4	2010	Evaluating Cloud Platform Architecture with the CARE Framework	Liang Zhao	Australia	36
5	2010	Approaching Non-functional Properties of Software Product Lines: Learning from Products	Julio Sincero	Germany	35
6	2012	A Design Pattern to Build Executable DSMLs and Associated V and V Tools	Benoit Combemale	France	27
7	2010	Model-Based Methods for Linking Web Service Choreography and Orchestration	Jun Sun	Singapore	24
8	2010	Evaluating Mutation Testing Alternatives: A Collateral Experiment	Marinos Kintis	Greece	22
9	2013	Suggesting Extract Class Refactoring Opportunities by Measuring Strength of Method Interactions	Giuseppe Pappalardo	Italy	21
10	2010	Bridging the Gap between Fault Trees and UML State Machine Diagrams for Safety Analysis	HyeonJeong Kim	South Korea	20

APSEC 2013 have citations equal to 1 or less than 1. We compute the skewness and kurtosis metrics to measure the symmetry (or lack of symmetry) and whether the citation data is heavy-tailed or light-tailed relative to a normal distribution. We observe that distribution for the years is positively skewed and hence the probability density function has a long tail to the right. We observe that the distribution is highly skewed for the year 2010, 2011, 2012 and 2013 and moderately skewed for the year 2014. We observe that the probability density function for the year 2010 and 2013 has a higher kurtosis (more peaked at the center) than the kurtosis value for the year 2011 and 2012. Year 2014 has a lower kurtosis value in comparison to all other years which means that the distribution for the year 2014 is less peaked or more flat relative to other years.

## VI. SCHOLARLY OUTPUT OF COUNTRIES

We analyze the scholarly output of various countries contributing to the success of APSEC. We extract the country of affiliation for every co-author. If an author has published multiple papers in a particular year or across years then we award multiple points to the affiliated countries. Our analysis reveals that authors from 37 different countries have contributed to APSEC from the year 2010 to 2015. The Top 3 countries (8.1% of the countries) have a contribution of 57.68% and the Top 5 countries (13.51%) have a contribution of 67.53%. The graph in Figure 2 displays the Top 10 countries with the highest scholarly output and contributions.

The Top 10 countries are: China (CHN, 446) Japan (JPN, 282), India (IND, 109), France (FRA, 79), Australia (AUS, 64), Sweden (SWN, 47), Germany (GER, 44), South Korea (SKR, 51), USA (USA, 38) and Taiwan (TWN, 35). A value of China (CHN, 446) means that there are 446 author entries from China in the dataset. The graph in Figure 3 displays the scholarly output of countries with a ranking of 11 to 20: Singapore (SGP, 33), Finland (FIN, 31), Austria (AUT, 29), New Zealand (NZ, 25), Canada (CAN, 17), Switzerland (CHE, 16), Italy (ITA, 13), United Kingdom (UK, 13), Iran (IRN, 12) and Norway (NOR, 12). We observe that Netherlands, Malaysia, Morocco, Greece, Luxembourg and Turkey have a score of 8, 7, 7, 5, 5 and 4 respectively. There are several countries with a low scholarly output: Chile (3), Pakistan (3), Czech Republic (2), Portugal (2), Spain (2), Thailand (2), Vietnam (2), Denmark (1), Mexico (1) and Sudan (1).

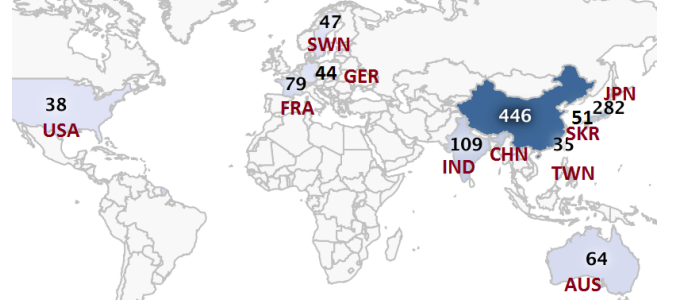


Fig. 2. Top 10 Countries with the Highest Scholarly Output and Contributions

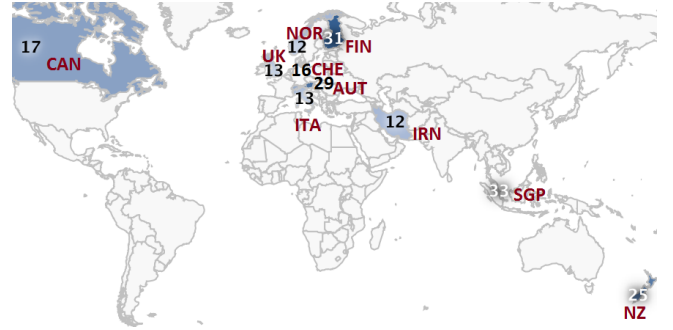


Fig. 3. Top 11 to 20 Countries with the Highest Scholarly Output and Contributions

Table VIII displays data on country of author and respective frequency over a period of 6 years. Table VIII reveals that China and Japan are the top two most contributing countries to APSEC. Table VIII shows that most of the countries are from Asia-Pacific region except Canada, Finland, France and USA.

## VII. PROLIFIC AUTHOR, AUTHOR CHURN, AVERAGE AUTHOR PER PAPER

Table IX shows the list of most prolific authors (from 2010 to 2015), the number of papers published by them (#PR) and the total number of citations (#CT) received by the published papers. Table IX also displays the count of papers published in each year (#YR). For example, Ashish Sureka published 1, 1, 1, 3 and 1 paper(s) in the year 2010, 2011, 2012, 2013, 2014 and 2015 respectively. We compute the total number of

TABLE VIII  
COUNTRY OF AUTHOR AND RESPECTIVE FREQUENCY DATA

2010		2011		2012		2013		2014		2015	
Country	Frequency(%)	Country	Frequency(%)	Country	Frequency(%)	Country	Frequency(%)	Country	Frequency(%)	Country	Frequency(%)
China	56 (33.94)	China	39 (23.78)	China	123 (29.85)	Japan	68 (23.69)	China	100 (39.22)	China	70 (41.67)
Japan	25 (15.15)	Japan	36 (21.95)	Japan	77 (18.69)	China	58 (20.21)	Japan	52 (20.39)	India	29 (17.26)
Australia	20 (12.12)	France	13 (7.93)	India	29 (7.04)	India	27 (9.41)	South Korea	33 (12.94)	Japan	24 (14.29)
USA	14 (8.48)	Australia	12 (7.32)	France	26 (6.31)	France	20 (6.97)	India	17 (6.67)	Australia	9 (5.36)
New Zealand	10 (6.06)	Canada	8 (4.88)	Taiwan	20 (4.85)	Finland	17 (5.92)	France	11 (4.31)	South Korea	7 (4.17)

TABLE IX  
LIST OF MOST PROLIFIC AUTHORS (COUNTRY OF AFFILIATION, NUMBER OF PAPERS PUBLISHED AND TOTAL NUMBER OF CITATIONS RECEIVED BY ALL PUBLISHED PAPERS) FROM APSEC 2010 TO 2015

Name	Country	# PR	# CT	# YR	# CL	Name	Country	# PR	# CT	# YR	# CL
Mikio Aoyama	Japan	11	22	1,1,1,3,3,2	27	Xiaohong Chen	China	5	7	0,1,0,1,1,2	17
Ashish Sureka	India	8	70	1,1,1,1,3,1	15	Shinpei Hayashi	Japan	5	19	1,1,1,2,0,0	16
Jing Liu	China	7	9	0,1,1,1,2,2	21	Li Zhang	China	5	9	0,1,1,1,1,1	10
Xiaoxing Ma	China	6	20	0,0,2,1,2,1	28	Kazuhiro Ogata	Japan	5	2	0,0,2,1,1,1	7
Shaoying Liu	Japan	6	21	0,1,2,0,1,2	5	Jian Lu	China	5	22	0,0,2,0,3,0	27
Motoshi Saeki	Japan	6	30	2,1,1,2,0,0	20	Horst Lichter	Germany	5	20	0,0,2,1,2,0	9
Chun Cao	China	6	18	0,0,2,1,1,2	25	Hironori Washizaki	Japan	5	8	0,0,0,1,3,1	35
Chang Xu	China	6	22	0,0,2,0,3,1	31	Hee Beng Kuan Tan	Singapore	5	4	0,1,2,2,0,0	9
Bixin Li	China	6	25	2,0,4,0,0,0	22	Ewan Tempero	New Zealand	5	185	1,1,1,1,0,1	15
Zhi Jin	China	5	24	1,1,2,1,0,0	15	Atul Gupta	India	5	22	0,0,2,3,0,0	9
Yoshiaki Fukazawa	Japan	5	8	0,0,0,1,3,1	35						

TABLE X  
TOTAL NUMBER OF UNIQUE AUTHORS (UNAUTH), NUMBER (NUMNEW) AND PERCENTAGE OF NEW AUTHORS ADDED EVERY YEAR (PERNEW)

Year	UNAUTH	NUMNEW	PERNEW
2010	157	0	
2011	158	147	(93.04 %)
2012	359	316	(88.02 %)
2013	271	184	(67.90 %)
2014	220	168	(76.36 %)
2015	157	119	(75.80 %)

TABLE XI  
AVERAGE AUTHORS PER PAPER

Year	Min.	Max.	Mean	Median
2010	1	8	3.51	3
2011	1	6	3.35	3
2012	1	7	3.38	3
2013	1	7	3.30	3
2014	1	13	3.70	3
2015	1	8	3.29	3

collaborating co-authors for each of the prolific authors listed in Table IX.

We observe from Table IX that higher productivity does not mean higher impact as some authors have a less papers in comparison to others but a relatively much higher impact. Table X displays the number of unique authors and number of new authors added every year with respect to all the previous years in the dataset. We calculate the author churn and observe that the author churn is more than 65% every year which means than at-least more than 65% of the authors are new in comparison to previous years. Table XI shows the minimum,

maximum, mean and median number of authors every year. Table XI reveals that the median value for the number of authors per paper is 3 for the 6 years. Our analysis reveals that there are several solo-authored papers as well as papers involving large collaborations (more than 6 co-authors per paper).

TABLE XII  
NUMBER AND PERCENTAGE OF RESEARCH TRACK PAPERS HAVING ALL AUTHORS FROM UNIVERSITY (AU), ALL AUTHORS FROM INDUSTRY (AI) AND AUTHORS FROM BOTH UNIVERSITY AND INDUSTRY (UI)

Year	NUM	AU	AI	UI
2010	47	42 (89.36 %)	1 (2.13 %)	4 (8.51 %)
2011	49	38 (77.55 %)	0 (0.00 %)	11 (22.45 %)
2012	122	96 (78.69 %)	11 (9.02 %)	15 (12.30 %)
2013	87	64 (73.56 %)	5 (5.75 %)	18 (20.69 %)
2014	69	54 (78.26 %)	7 (10.14 %)	8 (11.59 %)
2015	51	39 (76.47 %)	4 (7.84 %)	8 (15.69 %)

## VIII. COLLABORATION (UNIVERSITY-INDUSTRY, INTERNAL-EXTERNAL)

Joint authorship in scientific papers is an evidence of collaboration and interaction between researchers as well as institutions. Our objective is to study university-industry collaboration and knowledge flow between the two types of institutions. Table XII displays the data on university-industry collaboration. Table XII reveals that the percentage of joint university-industry papers varies from a minimum of 8.51% to a maximum of 22.45%.

We investigate the nature and scale of collaboration in APSEC papers (indicated by joint authorship) from the perspective of internal or external collaboration. Internal collaboration is a form of collaboration in which all the co-authors



in a paper (single or multiple-authors) are affiliated to one Institution only. External collaboration is defined as a form of collaboration which involves participation of two or more institutions (irrespective of whether the organizations involved are industry or university) in the production of the scientific output and the paper. Figure 4 displays a stacked bar chart indicating the percentage distribution of internal and external collaboration. Figure 4 reveals a good (above 35%) percentage of external collaboration. The percentage of papers having external collaboration varies from a minimum of 38.52% to a maximum of 46.94%.

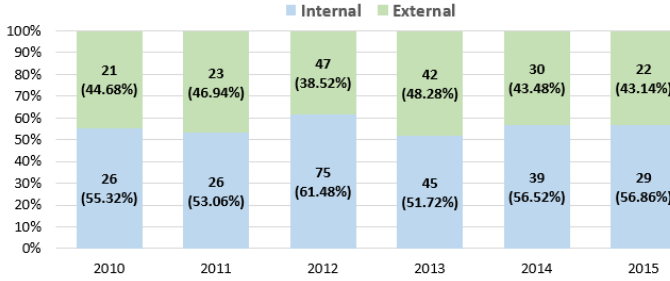


Fig. 4. Stacked Bar Chart Indicating the Percentage Distribution of Internal and External Collaboration

## IX. PROGRAM COMMITTEE CHARACTERISTICS

TABLE XIII  
PROGRAM COMMITTEE CHARACTERISTICS: NUMBER, DIVERSITY  
IN-TERMS OF COUNTRIES AND CHURN

Year	NUM	Country	NEW
2010	83	18 (21.69 %)	-
2011	95	18 (18.95 %)	40 (48.19 %)
2012	103	18 (17.48 %)	54 (56.84 %)
2013	83	17 (20.48 %)	63 (61.16 %)
2014	65	19 (29.23 %)	30 (46.15 %)
2015	75	14 (18.67 %)	8 (10.66 %)

The technical program committee for any conference is responsible for reviewing submitted papers and ensuring good quality reviews as well as selection of high quality papers. The size of the program committee should be according to the number of papers normally received by the conference so that the workload of the program committee members is reasonable or moderate. We extract the size of the program committee (for both the research and industry track) from the APSEC conference proceedings. Table XIII shows that the number of program committee members varies from a minimum of 65 in year 2014 to a maximum of 103 in 2012. The number of papers submitted at APSEC is in the range of 160 to 230 and hence the distribution of workload is moderate. APSEC is a long-running international conferences attracting papers from different parts of the world both from industry and academia. Diversity of institution, technical area of expertise and country is an important selection criteria for selecting program committee member and is an indicator of the quality of a conference. We extract the country of every program

committee member and compute the number of different countries. Table XIII shows that APSEC program committee is diverse and inclusive in-terms of the number of countries. For example, in the year 2010, there were 83 program committee members from 18 different countries (a diversity score of 21.69%). In year 2014, there were 65 members from 19 countries. The study by Vasilescu et al. reveals that the lowest observed PC renewal ratio is 8.8% for SCAM 2005, and the highest is 93% for GPCE 2007 [13]. Vasilescu et al. analysis shows that wider-scope software engineering conferences such as ICSE, FSE and FASE have a relatively higher PC turnover than narrow-scoped conferences [13]. Their analysis does not include APSEC. APSEC falls in the category of a wider scope software engineering conferences.

Annual churn and rotation of program committee members is essential for making sure that there is diversity, inclusiveness and cross-section of topic expertise, institution and geographical area. Inviting new program committee members and making space for them by rotating-off program committee members who have served for 2–3 years are normal guidelines for conferences. We compute the yearly churn in the program committee for APSEC 2010 to APSEC 2015. Table XIII shows that in the year 2011 there were a total of 95 program committee members out of which 40 (48.19%) were new and 55 were repeated from the year 2010. We observe that the highest churn was in the year 2013 (61.16%) and the lowest was in the year 2015 (10.66%). One of the objectives of conferences like APSEC is to stimulate interaction among researchers in industry and academia and provide a forum for computing professionals from both industry and academia to present and exchange research results. Hence, it is an important guideline for program committee chairs who lead the program committee member selection and invitation process to have a balanced representation from both industry and academia. We extract the affiliation of each program committee member and determine whether the member belongs to an industry or university. Table 6 displays (as a stacked bar-chart) the percentage distribution of program committee members across industry and university. Table 6 reveals an imbalance between industry and academia and is skewed towards university. The percentage of program committee members from university varies from a minimum of 69.88% to a maximum of 92.63%. We observe that for 3 years (2010, 2011 and 2012), the percentage of program committee members from industry is less than 10%. We notice an upward trend in percentage of program committee members from industry for past 3 years (8.43% to 24%).

## X. GENDER IMBALANCE IN AUTHORSHIP

Agarwal et al. conduct an analysis of women in computer science research by analyzing author data from 81 conferences including 11 conferences in software engineering [3]. Their experimental dataset consists of DBLP bibliography entries from the year 2000 to 2015. Their results reveal that 79% of the authors in the bibliography dataset consisting of 11 conferences and 16 years are male whereas 21% authors are

women authors [3]. We use the Genderize.io<sup>6</sup> API to determine the gender of all the authors in our dataset. The Genderize.io database (as of 10 June 2016) contains 216286 distinct names across 79 countries and 89 languages and can be used to determine the gender of a first name. The Genderize.io API returns the gender with a value of null if it is not able to determine the gender from a given first name. We manually checked the gender for 405 author names by doing a web search and checking the author profiles such as their homages consisting of pictures. Figure 5 shows the percentage of male and female authors for APSEC 2010 to APSEC 2015. Figure 5 reveals a gender imbalance as the percentage of women authors varies from a minimum of 18.47% (year 2013) to a maximum of 27.38% (year 2015). We observe an increasing trend over past 3 years however there has been decline in percentage of women authors from year 2011 to 2012 and 2012 to 2013. We also observe that there has never been a women General Chair out of the 11 General Chairs in APSEC from the year 2010 and 2015.

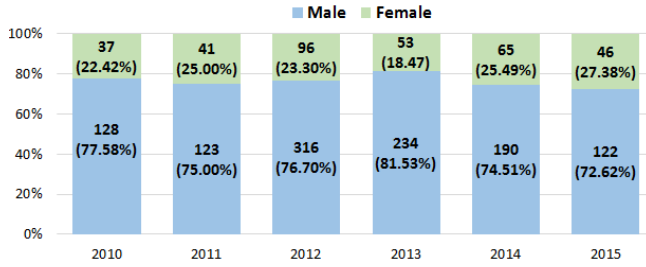


Fig. 5. Percentage of Male and Female Authors (Gender Imbalance)

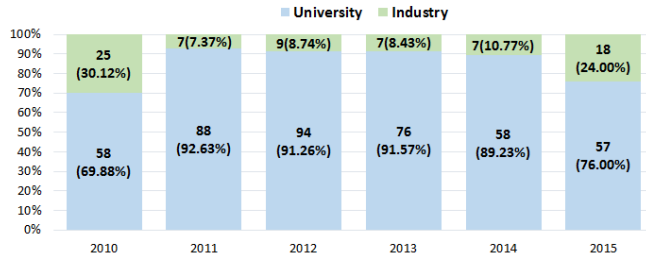


Fig. 6. Percentage Distribution of Program Committee Members across Industry and University

## XI. TOPIC ANALYSIS AND DISTRIBUTION

Our objective is to identify major research topics and trends in APSEC 2010 to APSEC 2015. We extract all the keywords from the BibTeX citation entries of every paper in our dataset. The keywords contains terms from Inspec (a major indexing database of scientific and technical literature) controlled and non-controlled indexing, author keywords and IEEE terms.<sup>7</sup> We map each key-term to one of the 15 knowledge areas (KAs) listed in the Guide to the Software Engineering Body

of Knowledge (SWEBOK Guide). The Guide to the Software Engineering Body of Knowledge (SWEBOK Guide) describes generally accepted knowledge about software engineering. We use SWEBOK V3.0 which is the most recent completely revised and updated version as of 11 June 2016. The 15 KAs are broad topics such as software requirements, software design, software construction, software testing and software maintenance. The SWEBOK V3.0 defines sections and sub-sections (sub-topics) within each KA. Table XIV displays the 15 KAs listed in SWEBOK Guide and the mapping of key-terms present in the BibTeX citation entry of every paper to the KAs. Table XIV reveals the top two knowledge areas for every year marked in bold and with a superscript. Our analysis reveals that software design is the most popular knowledge area. The second most popular knowledge area for the year 2011 and 2012 is software testing and software construction respectively. Overall (cumulative sum of all the 6 years) the top five knowledge areas are: software design, computing foundations, software testing, software construction and mathematical foundations. Our analysis reveals that there are not many papers in the area of engineering foundations, software engineering professional practice and software engineering models and methods. Mathew et al. conduct a topic modeling analysis of the abstracts and titles from 9291 papers published in 11 top-ranked SE conferences between 1993 to 2013 [14]. Their analysis does not include APSEC. Their analysis reveals that software testing is the most dominant theme in modern software engineering. Our results on APSEC topic modeling shows that software testing is also one of the most dominant area. Garousi et al. classify the top software engineering papers by their coverage of SE topics [12]. They adopted the classification of SE areas presented in the 2014 version of the SWEBOK. Their analysis reveals that models and methods and software design knowledge areas are the most popular topics in the top papers (in 50 and 34 of the top 135 papers, respectively) [12].

TABLE XIV  
15 KNOWLEDGE AREAS AND THE MAPPING OF KEY-TERMS PRESENT IN THE BIBTEX CITATION ENTRY

Topic	2010	2011	2012	2013	2014	2015	Sum
Software Requirements	87	88	208	146	123	37	647
Software Design	1391 <sup>1</sup>	177 <sup>1</sup>	438 <sup>1</sup>	319 <sup>1</sup>	276 <sup>1</sup>	133 <sup>1</sup>	133 <sup>1</sup>
Software Construction	75	100	334 <sup>2</sup>	214	132	53	936
Software Testing	95	133 <sup>2</sup>	286	206	151	59	961
Software Maintenance	90	117	326	202	157	44	795
Software Configuration Management	43	38	116	85	60	12	354
Software Engineering Management	41	48	87	53	48	10	287
Software Engineering Process	76	92 <sup>2</sup>	184	134	115	46	908
Software Engineering Models and Methods	10	26	61	36	42	5	155
Software Quality	71	96	270	170	150	38	689
Software Engineering Professional Practice	9	13	32	10	14	5	83
Software Engineering Economics	13	21	44	33	35	9	180
Computing Foundations	93	97	310	219	181 <sup>2</sup>	61 <sup>2</sup>	1007 <sup>2</sup>
Mathematical Foundations	113 <sup>2</sup>	107	329	232 <sup>2</sup>	174	52	930
Engineering Foundations	0	0	0	0	0	0	0

We categorize every paper in our dataset into one of the three categories: AU (All University), AI (All Industry) and UI (University Industry). AU consists of papers in which

<sup>6</sup><https://genderize.io/>

<sup>7</sup><https://www.computer.org/web/swebok>



all the co-authors are affiliated to university. UI consists of papers in which co-authors are affiliated to university as well as industry. Table XV displays top 3 topics for all university authored papers, all industry authored papers and university and industry collaboration papers. The information in Table XV provides insights on topics which are investigated more in industry in comparison to the topics in university and vice-a-versa. Similarly, our objective is to examine the research topics which are more common in papers involving university and industry collaboration. Our analysis reveals that software design is the most popular knowledge area in all the 3 categories. We observe that software testing is the second most popular knowledge area for the UI category and is not present in the top 3 list in AU category except for the year 2011. We notice that software engineering process is not present in the top 3 list within the AU category but is present two times in the AI category (year 2014 and 2015).

TABLE XV

TOP 3 TOPICS FOR ALL UNIVERSITY AUTHORED PAPERS, ALL INDUSTRY AUTHORED PAPERS AND UNIVERSITY AND INDUSTRY COLLABORATION PAPERS

Year	1st	2nd	3rd
<b>All University</b>			
2010	Software Design	Mathematical Foundations	Software Testing
2011	Software Design	Software Testing	Software Maintenance
2012	Software Design	Software Maintenance	Software Construction
2013	Software Design	Mathematical Foundations	Software Maintenance
2014	Software Design	Computing Foundations	Mathematical Foundations
2015	Software Design	Computing Foundations	Software Construction
All	Software Design	Mathematical Foundations	Computing Foundations
<b>All Industry</b>			
2010	Mathematical Foundations	Software Requirements	Software Maintenance
2011	No Papers	No Papers	No Papers
2012	Software Design	Software Quality	Computing Foundations
2013	Software Testing	Mathematical Foundations	Software Requirements
2014	Software Design	Software Maintenance	Software Engineering Process
2015	Software Quality	Computing Foundations	Software Engineering Process
All	Software Design	Software Testing	Computing Foundations
<b>Both (University and Industry)</b>			
2010	Software Design	Software Engineering Process	Computing Foundations
2011	Software Design	Mathematical Foundations	Software Testing
2012	Software Design	Software Construction	Mathematical Foundations
2013	Software Design	Software Testing	Software Construction
2014	Software Design	Computing Foundations	Software Quality
2015	Software Design	Software Testing	Software Engineering Process
All	Software Design	Software Testing	Mathematical Foundations

**APSEC 2016:** received 218 submissions (originally 225 with 7 withdrawn) of which the program committee accepted 43 papers as regular papers and 20 papers as short papers giving a 28.9% acceptance rate for both regular and short papers. The short version of this paper (A Review of Six Years of Asia-Pacific Software Engineering Conference) is accepted in APSEC 2016 happening in University of Waikato, Hamilton, New Zealand. The conference accepted three workshop proposals: International Workshop on Quantitative Approaches to Software Quality, Case Method for Computing Education (CMCE): A Strategy for Teaching Software Engineering and First International Workshop on Technical Debt Analytics. The keynote speakers and their topics are: (1) Cristina Cifuentes (Research Director, Oracle Labs Australia), Oracle Parfait: The Flavour of Real-World Vulnerability Detection, (2) Manu Sridharan (Samsung Research America), Program Analysis for Real-World

JavaScript, (3) Paul Ash (Director, National Cyber Policy Office, Department of Prime Minister and Cabinet, New Zealand Government), New Zealand in an interconnected world: delivering a secure, resilient and prosperous online environment. The conference accepted six tutorials: (1) Weka Data Mining Tool (2) Applying Model Driven Engineering Technologies in the Creation of Domain Specific Modeling Languages (3) SOUFFL: Datalog Compiler for Static Program Analysis (4) Interaction Design for Specifying Requirements (5) Learn to Build and Apply Software Analysis Tools with Interactive Visualization (6) Dynamic analysis of JavaScript with Jalangi. The conference is sponsored by: Oracle Labs, Google, Massey University, Rezare Systems, The University of Waikato, AUT Software Engineering Research Laboratory and the University of Auckland. The conference General Chairs are (1) Jens Dietrich, Massey University, New Zealand (2) Steve Reeves, University of Waikato, New Zealand. The Research Program Track Chairs are (1) Gail Murphy, University of British Columbia, Canada (2) Alex Potanin, Victoria University of Wellington, New Zealand. The program committee consists of 51 members.

## XII. CONCLUSIONS

We conclude that APSEC is successfully meeting its desired objective as it is able to attract a good number of papers (150 - 230) from different parts of the world both from industry and academia. The acceptance rate (between 30% - 35% on an average) demonstrates that APSEC is a moderately selective conference. APSEC has a good quality co-located workshops and tutorials covering diverse topics. The citation impact of the conference is moderate indicating that APSEC is maintaining its status as a Tier 2 conference. The papers published in APSEC demonstrates both university-industry collaboration as well as external collaboration. The scholarly output from various countries at APSEC shows that APSEC is able to attract good number of submissions from authors from different geographical regions in the world. The program committee of APSEC is diverse both from the perspective of representations from industry and academia and from different countries. There is a healthy program committee and author churn which indicates that the conference is broad and open.

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